AN ACOUSTICAL STUDY OF IPOD OUTPUT: EFFECTS OF HEADSETS AND CONTROL SETTINGS

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1. INTRODUCTION

Exposure to noise for long periods of time can cause damage to hearing (Fligor, 2006). Recently, the possible risk of noise-induced hearing loss for young adult wearers of portable audio devices has been questioned. Companies have launched numerous new devices and headsets to maximize the quality of sound in portable audio devices with mass storage capability, the most notorious being the Apple iPod. Apart from the specifications and control features of the device itself, its compatibility with different headphones will also alter the sound output. Three factors that differentiate one set of headphones from another are sensitivity, impedance, and frequency response. The purpose of this study is to evaluate several headsets through physical measurements and to decide if the resultant sound levels could be potentially hazardous to hearing health. We compared acoustical output measurements for samples of two genres of music played at four volume settings and different equalizer settings for three different headsets.

2. METHOD

Equipment

A Bruel & Kjaer Sound Quality Head and Torso Simulator (OSKAR dummy head) type 4128-C-001 with binaural microphones was used to measure the sound intensity on an A-weighted scale (dBA). All measurements made with OSKAR were recorded using Bruel & Kjaer's Pulse Labshop version 9.0.0.352.

A 30-GB Apple iPod Video MP3 player (MA146LL/A) was used to present the sound through different headsets to OSKAR's ears. A rectangular piece of paper divided into four equal segments was positioned below the iPod's visually displayed volume meter and used to code the volume setting as falling into one of four different ranges: 0-25, 25-50, 50-75 or 75-100%.

The output was measured for three different styles of headsets coupled to the iPod, one sold with the iPod by Apple and two alternatives sold by other companies. The brands of headsets tested and their corresponding specifications are as follows:

1. 30-GB iPod Video Earphones with a frequency range of 100Hz - 20kHz, sensitivity of -90 ± -3 dB, impedance of 32 O ± -15% and maximum power input of 10mW.
2. Mirai Earphones (MI-SL-730BV-Black) with a frequency range of 20Hz - 20kHz, sensitivity of 113dB ± 3dB, impedance of 32 O and maximum power input of 60 mW.
3. Panasonic Earphones (RP-HV288) with a frequency range of 10Hz - 25kHz, sensitivity of 104 dB/mW, impedance of 16 O and maximum power input of 50 mW.

Stimulus Material

Two 30-second sound clips were used for the tests; one from the Hip Hop genre the other from Electronica. These two particular kinds of music were chosen because of their current popularity with young adult listeners. Hip Hop songs are known for their strong percussions, thus most of their energy is concentrated in the low-frequency range between 1 and 4 kHz. In contrast, a typical Electronica song features synthetically produced sounds spanning a frequency range from 1 to 12 kHz.

Procedure

The evaluation of the iPod with the three different headsets took place in an IAC double-walled sound-attenuating booth. OSKAR was positioned on a small desk in a fixed location within this booth. There are 23 different equalizer settings options on the iPod and each of them was coded with numbers from 0 through 22. The sound intensity in dBA was recorded at 25, 50, 75, and 100% volume settings for each of the 23 equalizer settings.

The standard iPod earphones were the first to be assessed. After positioning the earphones in OSKAR's conchas, a 30-second Hip Hop sound clip was presented to OSKAR. The initial equalizer setting and volume were adjusted to 0=default and 25%, respectively. The average dBA level was recorded over the 30-second duration of the clip. The measurements were obtained in the same way for the three other volume levels at the default equalizer setting. We then tested the next equalizer setting at each of the four volume levels until all 23 equalizers had been tested using the Hip Hop song. The entire process was repeated with the Electronica test stimulus.

We calculated the average difference in dBA between Hip Hop and Electronica for each condition. The largest and smallest differences at each volume level were used to determine which equalizer settings made the most difference (see Results section). Based on these findings. two equalizer options were selected for further testing with the other two headphones. Specifically, Mirai and Panasonic earphones were tested at the equalizer settings 10=jazz and 13=lounge across the four different volume levels.

3. RESULTS

For the iPod earphones, we took the average dBA measurements of both ears and plotted them against the 23 equalizer settings at the four different volume levels.

Not surprisingly, dBA levels increased with volume. For Hip Hop, the average sound level (± SD) increased from volume 1 through 4 in the following manner: 52.5(±5.3), 61.9(±8.2), 77.9(±5.7) and 93.7(±5.7) dBA (see Figure 1).

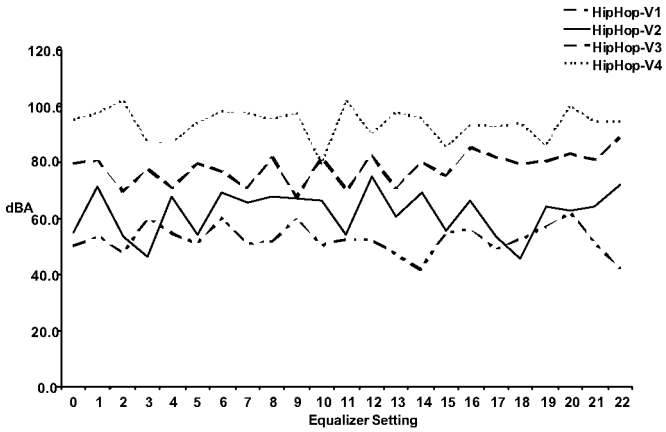

Figure 1. Average of left and right-ear dBA outputs for iPod earphones with the Hip Hop music at four volume settings and 23 equalizer settings.

Interestingly, the average dBA output was greater for Electronica than for Hip Hop for volume levels 1 through 4 respectively: 53.6(±3.2), 68.4(±4.2), 84.3(±3.3), 96.7(±3.6) dBA. The output depended on equalizer and volume settings; however, the variability was greater for Hip Hop.

At each volume and equalizer setting, the difference due to genre was calculated by subtracting the dBA outputs (Hip Hop - Electronica). For example, at volume 4, the largest negative difference was -19 dBA (equalizer 13, "lounge") and the largest positive difference was +8.3 dBA (equalizer 10, "jazz"). Thus, it seemed interesting to examine these two settings more closely. Accordingly, we tested the Mirai and Panasonic earphones at the default setting and with the equalizer set at 10=jazz and 13=lounge.

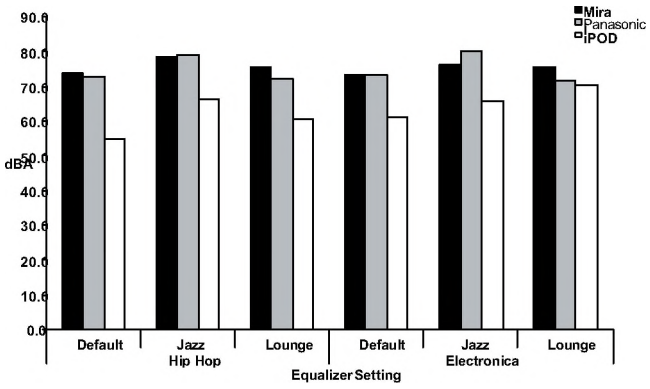

Figure 4. Left and right-ear average dBA outputs for three earphones at 50% volume with default, jazz and lounge equalizer settings for Electronica and Hip Hop.

All tests with the Mirai and Panosonic earphones were conducted at a 50% volume setting because that was assumed to be a typical user setting.

As seen in Figure 2, the dBA output from the Mirai and Panasonic earphones were comparable for each equalizer setting across the two test stimuli; the largest difference between them was 4.1 dB in the jazz setting for Electronica. They always yielded dBA output levels between 70 and 80 dBA. Furthermore, the outputs were consistently greater than the outputs from iPod earphones. At the default and lounge settings, a clear trend was seen with the Mirais louder than the Panasonics which were both louder than the iPods. This trend, however, was not maintained at the jazz setting where the Panasonics were slightly louder than the Mirais, but with both again being louder than the iPods.

4. DISCUSSION AND CONCLUSIONS

This acoustical study has investigated the level of sound output from different kinds of headsets and how output depends on factors such as equalizer and volume control settings. We found that the genre of music influences the level of sound output by any given headset. For instance, the Electronica sample was found to be consistently louder than Hip Hop at each volume setting using the iPod earphones. Furthermore, variability due to equalizer setting and headphone was noted and interacted to some degree with type of music and volume setting; e.g., at volume 4, there was a difference of 27.3 dB between the sound output in the jazz setting and the sound output in the lounge setting. This indicates that a simple change in equalizer setting at any given volume level can dramatically influence the output.

These physical measurements can be used to estimate the risk to human hearing. Of course, increasing the volume setting results in increasing dBA output. The alternative headsets such as the Mirai and Panasonic were consistently found to emit more hazardous sound levels than the standard iPod headset. It is commonly accepted that 85 dBA for a period of 8 hours is the maximum level of safe exposure (NIOSH). With every 3 dB increase, the duration for safe exposure is halved. Relating this information to our study, at 100% volume, regardless of type of music or equalizer settings, the sound intensity levels exceed 85 dBA. If a 3 dB increase reduces the duration of safe exposure by half, then the 27.3 dB change from one equalizer to the next could be potentially dangerous if listeners do not exercise caution.

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